



ILLINOIS STATE GEOLOGICAL SURVEY



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Division of the
STATE GEOLOGICAL SURVEY
M. M. Leighton, Chief

INFORMATION CIRCULAR NO. 15

FOURTH ANNUAL MINERAL INDUSTRIES CONFERENCE OF ILLINOIS

"Research on the State's Mineral Resources
and Their Utilization"

Urbana, Illinois
April 24-25, 1936

C O A L S E S S I O N S

ABSTRACT REPORTS OF
GENERAL SESSION, FORUM ON RESEARCHES IN PROGRESS,
AND SYMPOSIUM ON NEEDED RESEARCHES

Sponsored by

The Illinois State Geological Survey Division of the Department
of Registration and Education
The Engineering Experiment Station of the University of Illinois
Illinois Mineral Industries Committee

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Abstract reports of the addresses presented at the Fourth Annual Mineral Industries Conference of Illinois are available as follows:

Information Circular

COAL SESSIONS	No. 15
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CLAY AND CLAY PRODUCTS SESSIONS	No. 17
ROCK AND ROCK PRODUCTS SESSIONS	No. 18

The State Geological Survey does not assume responsibility for the statements herein presented.

Many of these papers are being published in full by technical or trade journals.

Friday Forenoon, April 24, 1936

GENERAL SESSION

The general session was under the chairmanship of Dean M. L. Enger of the Engineering Experiment Station of the University of Illinois. After welcoming the guests he introduced Dr. M. M. Leighton, Chief of the State Geological Survey, who outlined the objectives of the conference.

Dr. Leighton pointed out that prosperity in our early history rested upon the exploration and development of the country's untouched resources, whereas now it rests upon scientific discoveries and technologic developments of new and improved uses of these same basic resources. The new viewpoint given us by science is that we should make a complete inventory of our many types of resources by thoroughgoing investigations and then show that their constitution, composition, and properties are such that they can be transformed in various ways into ever increasingly useful products. The commonwealth that will make available this kind of information will make more profitable use of its resources, will be better able to meet competitive conditions, will create more industrial opportunities, will provide more widespread employment and will lay the soundest of foundations for prosperity and happiness of its people.

He stated that this conference was thus planned to discuss the importance of research as applied to the State's mineral resources and their utilization, to acquaint the industries with the research now in progress and the value of the results, to permit us all to catch a larger vision of the possibilities of well planned comprehensive research, to receive suggestions of additional researches needed from the standpoint of industrial experience, and to develop a joint interest in pursuing a research program with proper facilities and qualified personnel that will make for greater industrial activity and greater public welfare within our commonwealth.

The main address was given by Mr. Fred Wesley Sargent, President of the Chicago and North Western Railway Company, who was introduced by Dr. A. C. Willard, President of the University of Illinois. Mr. Sargent's subject was

"Research and the Immediate Future"

Mr. Sargent set forth the thesis that economic conditions will be improved by the production of new forms of wealth. Intensive research is producing new and improved means of production, and

is creating new industries and enormous demand for changes and improvement in old industries. The chemical industry illustrates the tremendous and rapid advances of scientific research. Many things are being done with chemistry that it was thought, heretofore, could only be done with machinery and muscle. Changes are coming so rapidly that frequently plants become obsolete long before they are worn out.

The intensive developments in science make it imperative that producers of raw materials ever be alert to scientific research. Pure research working in cooperation with honest business are forces that will move us into an era of unprecedented prosperity.

By enlarging the wants of men and women in diverse directions and by the consequent new demands arising for new additional services, scientific discoveries enlarge the field of human activity thereby creating new types of employment.

The Illinois coal industry, which in quantity and total value of product, is Illinois' largest mineral industry, ought also to be one of the greatest in concentrated value. Coal must not be looked upon only as a fuel to be destroyed by burning. Coal as coal only to burn may not long be able to hold its modern place of power, but through the aid of research it has limitless possibilities not only as a source of power but as a basis for vast new industries. Railroads are now burning dyes, medicines, perfumes and innumerable valuable chemicals along with their coal, all of which are wasted, and all of which ought to be captured for the service of mankind. New forms of competition are forcing the railroads to herculean efforts to hold their place in the field of transportation. Since some of these efforts are directed to producing power at lower cost, the coal industry must avail itself of research and more research to meet the competition of other fuels.

The possibilities of coal as a chemical raw material are illustrated by analogy to the rapid modern development in the products obtained from corn. In recent weeks the daily press has reported the discovery whereby a powerful explosive can be extracted from corn.

The railroads stand indicted because of their failure to take full advantage of scientific research possibilities. None of the major contributions to railroad development during the nineteenth century came from the railroads themselves. The telegraph was invented by Wheatstone, an English professor of philosophy, and Morse, an American artist; the Pullman sleeping car by a street contractor; the automatic coupler by Janney, a dry goods clerk; the automatic block signal system by Hall, a retired textile manufacturer; etc.

The railroads recently created the Association of American Railroads, and this organization created a Department of Research. This is a most important branch of this organization for

it should lead to things of permanent value - safety, greater efficiency and lower costs in producing and delivery transportation service.

It is no longer possible to stand by, trusting to luck, that some school teacher, artist, street contractor, or dry goods clerk will save the transportation industry in the future as they have in the past. The tempo of the times will not tolerate it. Progress through research is the order of the day. It is ridiculous to haul a ton and a half of dead weight per ton of freight and several tons of Pullman per passenger; to haul two to three thousand pounds of engine tender with load in order to have coal and water next to the power plant; and to use steam only once and then allow it to escape into the air.

New scientific achievements are eagerly recorded in the daily press. The most promising field of achievement is in the full use of all the riches wrapped up in our mineral resources, the development of transportation to the end that goods and persons will move freely and within the purchasing power of all. The true idols of the future will be the "Microbe Hunters," the "Hunger Fighters," the engineers, and the great students in pure scientific research.

"We are in the midst of a real, practical, scientific revolution that holds promise of a marvelous future for the raw products of our State, providing we have the vision and the courage to organize for research and thereby convert to useful purposes the riches now wasted, and through new and better processes make our minerals more valuable in all uses to which they may be applied to the end of a greater abundance for men and women everywhere."

Friday Afternoon, April 24

FORUM ON COAL

RESEARCHES IN PROGRESS

Following are abstracts of the papers presented at this forum which was one of four on Researches in Progress by the State Geological Survey and the Engineering Experiment Station of the University of Illinois, on the mineral resources of the State and their utilization. These forums covered four major fields - Coal, Oil and Gas, Clay and Clay Products, and Rock and Rock Products - and were held separately and concurrently on Friday afternoon.

Classification of Illinois Coals, by Gilbert H. Cady, Senior Geologist and Head of the Coal Division, State Geological Survey. The development of a satisfactory classification of coal as a short cut to accurate description depends on our fundamental knowledge of coal. Scientific classification of coal as a rock concerns the nature of the material initially and at present composing coal and the nature and extent of changes effected by geological agencies. That is to say, like other rock materials coal must be capable of fundamental classification on the basis of its constitution and on the basis of its position in the series extending from peat to anthracite. Accordingly it is agreed that fundamental classification must be in the two categories of "type" and "rank." The criteria for classification are partly geological and depend upon geological investigations of the occurrence of coal. Much information in regard to coal, however, is experimental or empirical and reveals the nature of coal behavior when subjected to standard conditions. Such are the standard proximate analysis, calorific value and ash fusion determination and results of other standard tests such as are available for Illinois coals. The correlation of this empirical information with type and rank classification of coal as a rock material is highly desirable to achieve a sound use classification. Unfortunately research in the physical constitution of coal to yield information that will make possible a natural petrographic classification has proceeded much more slowly than the accumulation of empirical data, hence the scientific bases for classification into type and rank are still insecure. It is therefore exceedingly important that fundamental investigation into the constitution of coal and the physical criteria for classification by rank shall be actively pursued. The State Geological Survey is endeavoring to enlarge the field of knowledge of coal constitution and is seeking physical criteria of rank differentiation whereby the significance of empirical data may be more fully understood.

Coal Preparation and Utilization, by David R. Mitchell, Assistant Professor of Mining and Metallurgical Engineering, University of Illinois. Current investigations pertaining to coal preparation and utilization now being carried on at the Engineering Experiment Station of the University of Illinois include: (1) A study of the character of coal mine waste, particularly picking table refuse, to determine its possible uses. Results are soon to be published on a study of the possible recovery of coal which constitutes approximately 40 per cent of the discard, and a study of the recovery of pyrite is in progress; (2) the effect of fines and free impurities on steam costs and boiler plant operation. These are being carefully tested at the University power plant; and (3) investigations pertaining to the reduction or elimination of the sulphur problem in using Illinois coals. Particular attention is being given the removal of deleterious sulphur compounds from stack gases.

Constitution of Coal in Relation to its Use, by Louis C. McCabe, Coal Division, Illinois State Geological Survey. The breakage characteristics of the three principal banded ingredients of Illinois coals have a great deal to do with the kind of coal that goes into the prepared sizes. Both vitrain (bright bands) and clarain (duller laminated coal) may be found in the lump, but most of the fusain will be found in the screenings, or if the coal is dedusted, it will be found in the dust. The 3 x 2 egg may have some of the smaller vitrain bands but for the most part is clarain. The No. 2 nut is still richer in clarain. In most coals the No. 3 nut is 8 or 10 per cent higher in vitrain than the coal bed from which it is mined. Vitrain continues to concentrate below 48-mesh in most instances until the 100 or 200-mesh size is reached. Below this the fusain is ordinarily highly concentrated.

Washing may further separate the ingredients. In the minus 1 1/4-inch screenings from one mine, 58.9 per cent floats at 1.30 sp. gr. The coal floating is 58.2 per cent vitrain, 40.0 per cent clarain, 1.1 per cent fusain and .7 per cent middling-refuse. The average vitrain content of the coal bed is 20 per cent.

An approach to the problem of utilization from the viewpoint of the coal constitution is now in order. Research into the burning characteristics of the different ingredients in stokers is projected. The best combinations of ingredients for domestic coke production and for powdered fuel firing are problems that must also be solved.

In considering the problem of the constitution, the following general summary as to the nature of the 44 million tons of coal mined in Illinois last year can be made:

8 million tons of vitrain, greatly swelling coal with less than 2 per cent ash.

1 million tons of fusain, largely dust, with 65 to 70 per cent fixed carbon.

35 million tons of clarain, less strongly swelling than vitrain and as a result freer burning, with an average ash of 6 to 8 per cent.

Standardization in Coal Analysis and its Application to Plant Control and Marketing, by O. W. Rees, Associate Chemist, Illinois State Geological Survey. Coal analysis is of great importance today due to the increased need for such analyses in preparation plant control and to the increasing tendency to market coal by analysis. That such analyses should be made as accurately as possible is therefore imperative. On large tonnages of coal analytical errors may prove costly. On the basis of a consumption of a thousand tons of coal per day at a base price of \$2.00 at the mine an error of one per cent in the B.t.u. value would represent a difference of \$20.00 per day or \$7300 per year. Penalties for other errors will rapidly add to this.

The nonhomogeneous character of coal makes sampling and analysis difficult. Furthermore many of the methods available for coal analysis are of the empirical type, that is, procedures in which details of procedure are definitely specified. Because of this it is necessary to follow closely standard procedures in order to obtain results which can be duplicated. Emphasis is placed on proper sampling both in obtaining the proper gross sample and in properly preparing this sample for analysis, proper housing of the laboratory to eliminate shock, sway, dust and dirt, and close adherence to standard procedures of analysis as specified by the American Society for Testing Materials (D 271-33).

Methods of properly sampling prepared products and new methods of analysis, for example, a method for differentiating between surface and inherent moisture are needed. There is, therefore, a need for analytical research in coal analysis.

Carbonization of Illinois Coals, by Gilbert Thiessen, Associate Chemist, Illinois State Geological Survey. The growing market for domestic coke offers great possibilities for the Illinois coal industry. This is a steady market, not subjected to the wide fluctuations of the metallurgical and other industries using coke. Because of their higher volatile matter contents, cokes from Illinois coals shrink severely and form fingery pieces if too completely devolatilized. A highly fingered coke offers difficulties in pushing from standard slot type ovens. Coking in ovens having a wide, flat section avoids these difficulties. Studies have been made of the behavior of Illinois coals under heat and their softening, decomposition and solidification temperatures determined. These coals rapidly lose their coking powers on storage, especially so if they have been subjected to any considerable exposure before storage. The rate of coking in any equipment is governed by the rate of heat

transfer across the zone of plastic coal which divides the unchanged coal from the coke. Temperature gradients of 400° F. or more are found across this zone which is from one-quarter to one-half inch in thickness. The temperature conditions in a charge of coal being coked in a Knowles type sole-flue oven throughout an entire coking period were determined. The composition of the coal in terms of its banded ingredients has a great influence upon the characteristics of the coke produced from it. Because of their high moisture and oxygen contents as compared with other coking coals, lower by-product yields must be expected from Illinois coals.

Smokeless Briquets from Illinois Coal Fines, by R. J. Piersol, Physicist, State Geological Survey. This paper reviews the results of the studies on smokeless briquetting presented in detail in Report of Investigations No. 41, which covers three distinct, but related, fields which are (1) the production and properties of smokeless briquets, (2) the processing of Illinois coal fines into a smokeless coal product, and (3) the development of a laboratory method for the quantitative measurement of the smoke content, together with the design of the necessary equipment.

A commercial dry brick press may be used to form four five-pound briquets simultaneously, each briquet being 5 x 10 x 2 1/2 inches in size, the press having a capacity of 120 tons per 24-hour day. Such briquets burn with a blue flame, without visible smoke, and with high radiant heat; the combustion takes place from the surface inwardly, without swelling or crumbling.

The smokeless product is processed by the liberation of 15 per cent of the smoke-producing volatile matter at a temperature of about 480° C. applied for a 10-minute period.

The smoke index is a numerical value of the smoke content of coal, expressed as the product of the average absorption of light (per cent) by the time of combustion (seconds) per gram of coal, the accuracy being within 5 per cent.

Smokeless briquets were made from Illinois coals which have less than one-third of the smoke index of that of so-called natural smokeless coals.

Inventorving the Coal Resources of Illinois, by J. Marvin Weller, Geologist, Illinois State Geological Survey. A comprehensive field investigation of the Pennsylvanian or "Coal Measures" rocks of the State by members of the Geological Survey has been in progress for ten years and is nearing completion. This study has shown that the different kinds of Pennsylvanian rocks normally occur with certain definite relations to one another and that a certain sequence or cycle of beds is more or less incompletely repeated about forty times. Although only six coal seams in the State have been mined on an important scale, each of these cycles includes a coal. Studies of outcrops and drill records prove that most of the

cycles are persistent throughout the State and they furnish an important new means of correlation because even though a coal is locally absent, its exact position may be determined from the association of the other rocks. Most of the coals have been traced in outcrop around the Illinois coal field and observations of their characters, especially variations in their thicknesses, make possible predictions regarding their presence beneath more or less deep cover within the coal field. Finally the distribution of all of the important coals was briefly outlined and the conclusion reached that important coal reserves occur at greater depth in already active mining districts but that as the thicker seams are exhausted mining of certain thinner seams will spread outward into all parts of the coal field.

In his discussion of this subject, Dr. G. H. Cady pointed out that many mining problems resulting particularly from inequalities of the coal and its roof are directly related to variations in the normal sequence of the Pennsylvanian rocks and that an understanding of this sequence is of great importance in reaching a practical solution of such problems.

Saturday Forenoon, April 25

SYMPOSIUM ON

COAL RESEARCHES NEEDED

On Saturday forenoon symposia on Needed Researches from the industrial viewpoint were held separately and concurrently for Coal, Oil and Gas, Clay and Clay Products, and Rock and Rock Products. These meetings were planned in order to provide industries with a special opportunity to offer their suggestions of needed researches. Following are abstracts of the papers presented at the Coal symposium.

Factors to be Investigated in the Satisfactory Stoker Use of Illinois Coals, by C. V. Beck, President, St. Louis Coal Company, and Executive Director, Coal Exchange, St. Louis. The underfeed stoker of the screw feed type seems well adapted to the small operation, such as residential heating and the ordinary commercial job, which by reason of their number constitutes a large field. Some of their disadvantages might be overcome through experimental variation in the rate of feed, size or shape of retort or tuyeres, volume and pressure of air supplied, and depth of fuel bed maintained. Some of the problems suggested for experimental solution include

the effect of various sizes and types of retorts and tuyeres in relation to the amount of coal fed; how rapidly a fire will normally burn down as against a certain upward feed and certain air pressures; experimentation with stoker controls to determine how much fuel should be fed and how often; and development of stoker control that will permit the best possible results from low-grade coal. The suggestion was made that enforced intermittent off-and-on operation permitting fuel bed to cool down periodically may permit burning of low grade fuels otherwise unburnable in this type of stoker, and that investigation should be made into what happens to a fuel bed during the period in which green coal is being brought up to the ignition point.

Federal Regulations of the Bituminous Coal Industry, by George W. Reed, Vice-President, Peabody Coal Company, Chicago, and Chairman, Bituminous Coal Producers' Board for District 10.

Congressional efforts to regulate the coal industry are an outgrowth of many special Commission investigations over the last 20 years dealing with strikes, coal shortages especially during war-time, high prices, destructive competition, price-cutting and wage-cutting, disorder and poverty in the mining districts, and waste of coal resources. Under the N.R.A. code, operative from September 1933 to May 1935, conditions were greatly improved.

The Bituminous Coal Conservation Act of 1935 was designed to meet the whole situation, providing a minimum of regulation necessary to stabilization of the industry. Price-fixing provisions, based on average costs of production for several districts, will compel more efficient operation in badly managed or incompletely equipped mines, and will assure mine employees living wages. Consumers are assured against price levels reaching abnormal and unreasonable heights. Their interests are protected at all times by a Consumers Counsel appointed by the President. The Act does not establish wages or hours of employment, but provides for their establishment through collective bargaining, so that different rates will apply to different labor classifications in different producing districts. The code provides for appeals by code members or districts to the Bituminous Coal Commission, hearings by the Commission, and review by the Circuit Court of Appeals of the United States of orders issued by the Commission or the Labor Board. Penalties are provided for attempts to evade the code.

The country is divided into 23 producing districts, each to be under a District Board of from 3 to 17 members to be chosen by majority vote of district tonnage for 1934. Each District Board is empowered to make such price variations as may be deemed necessary. The minimum prices so established must reflect as nearly as possible the relative market value of the various kinds, qualities, and sizes of coal, shall be just and equitable as between producers within a district, and shall have due regard to the interest of the consuming public, and no minimum price shall be established that permits dumping.

Classification of Illinois coals has been based on rank as determined by the Illinois State Geological Survey and published in Bulletin 62. The problem of what other factors are pertinent in the valuation of coals is still being studied.

The Regulation of Moisture in Coal as a Factor in Beneficiation, by Thomas E. Shaugnessy, Combustion Engineer, Northern Illinois Coal Corporation. Efforts to regulate the moisture content of coal (which begins to vary as soon as the coal leaves the mine) are made when the coal is being sized, prepared, and loaded for shipment. Where washeries are employed to control the ash content, heat drying or dehydration is needed to reduce the excess moisture, although it does not reduce it below the original moisture content of the coal in the mine. Suggested lines for further research included (1) the degree to which regulation and reduction of moisture would affect the rank, grade, and heat index classification of a coal; (2) the regulation of moisture in agglutinating and non-agglutinating, in weathering and non-weathering coals; (3) the effect of moisture regulation on coals which disintegrate rapidly; (4) limits to which the moisture content of a coal may be regulated. Practical benefits of moisture regulation of coal to both producer and consumer were pointed out, and a wet-washing and dehydrating installation was described in detail.

The Significance of Hydrogenation with Respect to Illinois Coals, by Frank H. Reed, Chief Chemist, and Gilbert Thiessen, Associate Chemist, Illinois State Geological Survey. Present indications point to the possibility of a domestic petroleum shortage by 1940 and possibly a considerable shortage by 1945. Improved recovery and more efficient utilization methods will not prevent the necessity for us to look for other sources of liquid fuels. The most logical source is coal from which liquid fuels can be made by three procedures, carbonization, destructive hydrogenation, and synthesis from coal gasification products. The by-products of coal carbonization cannot be expected to furnish an important part of our liquid fuel supplies. It is possible to produce liquid motor fuels and lubricants by catalytic synthesis from carbon monoxide and hydrogen obtained by complete gasification of coal. Construction of a plant for such synthesis has been started in Germany. The first unit of this plant will have a capacity of 200,000 barrels of gasoline per year. Most of the synthetic motor fuel produced today is obtained through the destructive hydrogenation of coal. A recently erected plant in England is designed to produce 100,000 tons per year of motor fuel from 500,000 tons of coal besides 10,000 tons from low temperature tar and 40,000 tons from creosote oil. This plant is valued at 12 1/2 million dollars and employs 2000 men. The cost of synthetic motor fuel is stated to be between 12 and 17 cents per gallon in contrast to a refinery price of about 5 cents per gallon for petroleum gasoline in the United States. Refineries in the Illinois market area have been processing about one-seventh of the United States production of petroleum and producing 60 million barrels of gasoline annually. To produce this gasoline from coal

would require about 35 million tons of coal. We have much to learn about the hydrogenating properties of Illinois coals. We must start now to obtain this information if we are to have it ready when it will be needed. It is suggested that a cooperative research project with federal and other state agencies might most effectively and economically furnish this information.

